

Docket No. 10592RRUS01U

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EL356872832US**METHOD AND APPARATUS FOR PROCESSING CONTROL
MESSAGES IN A COMMUNICATIONS SYSTEM**

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1. Field of the Invention:

The present invention relates to an improved communications system and in particular to a method and apparatus for processing control messages in a communication system. Still more particularly, the present invention provides a method and apparatus for processing control messages through a packet-based portion of a communications system.

2. Background of the Invention:

Voice communications over packet-based networks are becoming more common within communications systems. Currently, many of these networks are Internet Protocol (IP) networks. These voice communications are referred to as voice over IP or VoIP. The use of these networks for communications takes advantage of resources already in place. Further, companies with Internet systems also may implement voice over IP communications using their existing network systems. Further, in addition to voice, the presence of a packet-based network allows for various services to be offered based on the packet-based technologies, such as, for example, providing e-mail messages and documents across the same terminal device.

One problem with a packet-based network system used for voice is the fact that IP networks, such as the Internet, consists of multiple routers, which are linked together. These routers store the data packets and forward them to the most appropriate output links, which may range from 64 kilobits per second over a twisted pair to 155 megabits per second or greater over fiber based links.

IP is a datagram-based approach and offers no guarantee of quality. For example, network delay may be variable depending on the traffic within the network. In an IP network, packets are self-steering and dependant on the IP address. As a result, packets may take different routes depending on how busy

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each router is within a network. In contrast, with a fixed circuit, the delay is fixed and known. A further problem with IP networks is that depending on the traffic within a network, packets may be dropped. For transmission of data, packets may be resent. As a result, the packets retransmitted are delayed more than other
5 packets taking the same route, which are not dropped. This retransmission mechanism is appropriate for applications, which are insensitive to delays. These mechanisms are commonly used in applications, such as, for example, Web browsers and e-mail programs.

On the other hand, with delay sensitive applications, variable delays and
10 dropping of packets are undesirable. When the delay sensitive application includes transmitting voice data, variable delay or dropping of packets is unacceptable to maintain an appropriate quality of service for a call. Another instance in which the unpredictable delay or dropping of packets is unacceptable occurs as with control messages used to set up, manage, and terminate a session
15 for a call. Currently, no mechanism is present for handling control messages over a packet-based network to guarantee delivery of these messages.

Therefore, it would be advantageous to have an improved method and apparatus for handling control messages in an IP communications system.

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EXPRESS MAIL NO.
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An improved method and apparatus for handling control messages is
5 provided in which priority or preferential processing of these control messages
occurs within a packet-based portion of a communications system. More
specifically, the present invention provides a method in a communications system
for processing control messages for a session in a packet-based network within the
communications system. A priority indicator is placed in a control message
10 handling a session within the communications system through the packet-based
network. Applications handling control messages in the packet-based network
will provide priority or preferential handling of the control message containing the
priority indicator.

In the depicted examples, some nodes contain applications, which handle
15 control messages, while other nodes only handle packets transporting the control
messages and do not process the control messages themselves. In this case,
another indicator also may be placed in the header of a packet transporting the
control message. This indicator is used by nodes, which handle the packets to
provide priority processing of the packets in these nodes. In this manner, the
20 control message may be given priority handling even in nodes in which an
application handling control messages is absent. Thus, priority handling of the
control message is provided within the packet-based network within the
communications system.

Other aspects and features of the present invention will become apparent
25 to those ordinarily skilled in the art upon review of the following description of
specific embodiments of the invention in conjunction with the accompanying
figures.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

10 **Figure 1** is a diagram of a communications system in accordance with the preferred embodiment of the present invention;

Figure 2 is a blocked diagram illustrating control message flow in accordance with a preferred embodiment of the present invention;

Figure 3 is a diagram of control message flow through packet-based routers in accordance with a preferred embodiment of the present invention;

15 **Figure 4** is a block diagram of a node in which the present invention may be implemented in accordance with a preferred embodiment of the present invention;

Figure 5 is a diagram of a protocol stack in accordance with preferred embodiment of the present invention;

20 **Figure 6** is a diagram control message depicted in accordance with a preferred embodiment of the present invention;

Figure 7 is a diagram of an IP packet in accordance with a preferred embodiment of the present invention;

25 **Figure 8** is an example of a priority AVP format in accordance with a preferred embodiment of the present invention;

Figure 9 is a flowchart of a process for generating a control message in accordance with a preferred embodiment of the present invention; and

Figure 10 is a flowchart of a process used to process control messages in accordance with a preferred embodiment of the present invention.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to the figures and in particular with reference to
5 **Figure 1**, a communications system is illustrated in accordance with a preferred
embodiment of the present invention. In this example, communications system
100 includes a visitor access provider network **102**, home access provider network
104, home Internet Protocol (IP) network **106**, authentication, authorization, and
accounting (AAA) broker network **108**, home access provider network **110**, SS7
10 network **112**, IP network **114**, and public switched telephone network (PSTN)
116.

AAA broker network **108** includes AAA services. These AAA services
consist of authentication, authorization, and accounting services. The
authentication services are used to verify the identity of an entity. Authorization
15 is a service used to determine whether the requesting entity is allowed access to a
resource. Accounting services collect information on resource usage for purposes,
such as trend analysis, auditing, billing, or cost allocation.

SS7 network **112** is a signaling system number 7 network used for
switching data messages used for connecting calls and maintaining the signaling
20 network itself. SS7 network **112** is designed for use with voice networks, such as
PSTN **116**. IP network **114** and PSTN network **116** are both used for carrying
voice calls from visitor access provider network **102** to some destination in this
example. The destination may be somewhere within PSTN **116** or to HA **110**.

In **Figure 1**, visitor access provider network **102** includes a mobile station
25 **118**, a radio network **120**, a visitor location register (VLR) **122**, a visited AAA
server **124**, and a foreign agent (FA) functionality **128**, which is hosted on a
device or platform. In this example, radio network **120** may take various forms,
such as, for example, time division multiple access (TDMA) or code division
multiple access (CDMA) cellular system. Of course, radio network **120** may be
30 implemented using any type of radio system. A call may be initiated or
terminated at mobile station **118** through radio network **120**. The route of a call

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may pass through PSTN 116 or IP network 114. If the call is to be placed in packet form, FA functionality 128 handles the transmission of these packets. FA Functionality provides routing services to mobile station 118. Often times, this functionality is embodied in a router on the visited network of mobile station 118.

5 More information on FA functionality may be found in RFC 2002, entitled *IP Mobility Support*, which is available from the Internet Engineering Task Force (IETF). The setting up, terminating, and management of the call may be handled through SS7 network 112, VLR 122, and home location register (HLR) 126. This setting up, terminating, and management is also just referred to as managing or

10 handling. VLR 122 is used to store subscriber information for a subscriber in a particular service area, such as within visitor access provider network 102. This information may be obtained from HLR 126, which is a functional unit used for managing mobile subscribers through maintaining all subscriber information. Thus, when a subscriber using a mobile station, such as mobile unit 118, travels

15 from one service area to another, the information from HLR 126 may be sent to the VLR for that particular service area. All of the signaling and control messages are handled through SS7 network 112, while the voice data for the call is handled through PSTN 116.

With packet-based calls, such as voice over IP, the messaging and the

20 voice data are both passed through IP network 114. In this case, visited AAA server 124 and FA functionality 128 provide a similar function to VLR 122 within visitor access provider network 102. In this case, the control messages, such as a registration request generated by mobile station 118, will be forwarded to FA functionality 128. FA functionality 128 will then send these messages to HA 110

25 through IP network 114. FA functionality 128 may also send the AAA messages to visited AAA server 124 and which in turn forwards them to home AAA server 129 via IP network 114. In this example, FA functionality 128 is also referred to as the home AAA server. Home AAA server 129 within home IP network 106, AAA server 130 within AAA broker network 108, and visited AAA server 124

30 provide functions similar to FA functionality 128, VLR 122, and HLR 126.

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A mechanism for handling control messaging through IP network 114 is used in accordance with the preferred embodiment of the present invention. This mechanism provides a priority or precedence mechanism for the handling of control messages by various nodes within IP network 114. This mechanism is used for all control messaging related to a session for a call. A session is the active connection between two nodes used in a call. These messages are for different functions, such as, for example, those used for IP mobility including handoffs, registrations, and AAA functions. IP mobility allows for a mobile station, such as mobile station 118 to travel from network to network in different service areas and still have an uninterrupted connectivity. For example, mobile station 118 has a home network, home access provider network 110, and is currently located in visitor access provider network 102. The control messaging used for registering mobile station 118 within visitor access provider network 102 and for handling calls initiated from and terminated to mobile station 118 is provided priority or precedence over other types of messages transported through IP network 114. The priority is assigned to this kind of messaging because control messages are handled by delay sensitive applications. Radius and diameter are examples of applications containing control messaging functions. AAA broker network 108, in this example, provides address resolution service to the visited networks that do not have a service level agreement with a particular home network. AAA broker network 108 also may provide security parameters for establishing sessions between visited and home networks. These applications include, for example, those found in home AAA 129, AAA server 130 and visitor AAA 124.

Communications system 100 is an exemplary communications system in which the present invention may be implemented. The illustration is not meant to imply architectural limitation to the present invention. Other types of inventions may be used in place of those illustrated.

Turning next to **Figure 2**, a blocked diagram illustrating control message flow is depicted in accordance with a preferred embodiment of the present invention. In this example, control messages are generated by home AAA server

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200 for receipt and use by visited AAA server 202. Home AAA server 200 may be, for example, home AAA server 129 in **Figure 1** while visited AAA server 202 may be visited AAA server 124 in **Figure 1**. Home AAA server 200 may be providing control messages relating to authentication, authorization, or accounting to visitor server 202. In this case, these control messages are for the delay sensitive applications, such as voice/video streaming. A priority indicator is placed into each of the control messages sent from home AAA 200 to visited AAA server 202. These control messages are routed through a path including AAA server 204 and AAA server 206. The applications (i.e., radius and diameter) in these servers will route the control messages to visitor server AAA 202. In routing the control messages, the messages are examined to see whether an indicator has been sent within the control message. If the priority indicator is set in the control message, the message is handled accordingly. The indicator in a message may contain different levels of priority, such as, for example, 1, 2, 3, and 4 with 1 having the highest priority. Alternatively, other types of indicators may be used, such as platinum, gold, silver, and bronze with platinum having the highest priority. Control messages having higher priority indicators will be processed or routed prior to control messages having lower level indicators or no indicators at all.

In the depicted example, messages are placed in a queue for processing. Typically, messages are processed in a first-in-first-out (FIFO) basis. When priority indicators are used, exceptions to FIFO processing are made. Messages having a priority indicator are placed ahead of messages without a priority indicator in the queue. With multiple or different levels of priority, messages having higher priority levels are placed ahead of messages with lower priority levels in the queue.

Turning next to **Figure 3**, a diagram of control message flow through packet-based routers is depicted in accordance with a preferred embodiment of the present invention. In some cases, control messages may be routed through nodes, which do not contain applications to control the flow of control messages. For example, within an IP network, such as IP network 114 in **Figure 1**, messages

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may be placed into IP packets for routing from a source to a destination through a number of different nodes, such as routers. These routers do not examine the control messages themselves, but route the data based on the headers in the IP packets. In this example, IP layer **300** generates IP packets containing data for control messages and sends them to IP layer **302**. These IP layers may be located in a home AAA server and a visited AAA server, such as home AAA server **129** in **Figure 1** and visited AAA server **124** in **Figure 1**.

In this case, the path between these servers passes through router **304** and router **306**. These routers do not examine the control messages, but process the IP packets based on the information in the headers of the IP packets. In such as case, IP layer **300** is instructed through a call or some other mechanism to set an indicator to provide priority handling of the IP packets. When an IP packet is received by router **304** or router **306**, the header of the IP packet is examined. In addition to identifying where to send the IP packet, a determination is made as to whether an indicator is set in the header of the IP packet to identify whether the IP packet is to be given priority in processing. If an indicator is set in the header, then that IP packet is processed prior to other IP packets without the indicator. For example, an IP packet containing the indicator will be placed in a processing queue prior to other packets without an indicator.

In this manner, priority handling of packets containing control messages may be obtained even in nodes, which do not contain applications that examine the control messages themselves.

Turning next to **Figure 4**, a block diagram of a node in which the present invention may be implemented is depicted in accordance with a preferred embodiment of the present invention. In this example, node **400** contains a bus **402** providing communication between processor unit **404**, memory **406**, communications adapter **408**, and storage **410**. Processor unit **404**, in this example, executes instructions, which may be located in memory **406** or storage **410**. Communications adapter **408** is used to send and received data, such as control messages. Node **400** may be used to implement different components of the present invention. For example, node **400** may be a router used to route IP

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packets, an AAA server, or any other server or communications unit used to route or handle control messages within a packet-based network, such as IP network 114 in **Figure 1**.

The illustrated example in **Figure 4** is not meant to apply architectural
5 limitation to the present invention. For example, although bus 402 is the depicted mechanism for providing communications between the components within node 400, any other sort of interconnect or communications mechanism may be used to provide communications between the different components within node 400.

Turning now to **Figure 5**, a diagram of a protocol stack is depicted in
10 accordance with preferred embodiment of the present invention. In this example, protocol stack 500 includes an application layer 502, a presentation layer 504, a transport layer 506, a network layer 508, a data link layer 510, and a physical layer 512. In the depicted example, protocol stack 500 is located in a node with an application that handles control messages.

15 These layers follow the Open System Interconnection (OSI) standard defining a framework implementing protocols in seven layers. Control is passed from one layer to the next, starting at the application layer in one station or device, proceeding to the bottom layer, moving over a communications channel to the next station or device, and proceeding back up the hierarchy. Protocol stack 500
20 may be found in a node, such as visited AAA server 124, HA 110, or FA functionality 128 in **Figure 1**.

The mechanism of the present invention is implemented in application layer 502 and network layer 508 in these examples. An application program in application layer 502 may generate or receive control messages. When generating
25 a control message, the application includes an indicator to provide priority processing by an application receiving the control message. Further, the application in the node generating the message may send a call or command to network layer 508 to provide for priority or precedence handling of IP packets containing the control message. In this example, network layer 508 includes an IP
30 protocol. In response to receiving a request to provide priority or precedence handling for a control message being transported using one or more IP packets,

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the headers of these IP packets will include an indicator used by other network layers located in nodes routing IP packets to provide priority or precedence in the processing of these IP packets.

5 In this manner, when control messages are routed by nodes that do not examine the control messages in routing the messages, priority in the handling of these messages is insured. In this manner, delays in the handling of control messages are reduced.

Turning next to **Figure 6**, a diagram of a control message is depicted in accordance with a preferred embodiment of the present invention. Control
10 message **600** is an example of a control message generated by an application to handle a session for a call. These messages may be, for example, a message to set up a session, a message to terminate a session, and a message to authenticate/authorize a user. Examples of other control messages include, for example, accounting record messages and mobility management messages.
15 Control message **600** includes a header **602** and a payload **604** in which attribute-value pairs (AVPs) are located. In this example, AVP **606** and AVP **608** are located within payload **604** of control message **600**. An AVP, in these examples, consists of three parts: an identifier, a length, and data. A unique AVP identifier is assigned to all data objects in order to be able to distinguish the data contained.

20 In this example, AVP **606** is a priority AVP used to provide priority or precedence for control message **600** in accordance with a preferred embodiment of the present invention. The present invention provides a new AVP identifier to indicate that the AVP is a priority AVP. Other AVPs that may be found within control message **600** include, for example, an IP address, an encryption code, an
25 e-mail address, authentication parameters, and a user ID. With AVP **606**, applications processing the control messages will provide the appropriate priority for precedence for the message based on AVP **606**. In these examples, control messages, such as control message **600**, a placed into a queue for processing by an application. When AVP **606** is present, the control message is placed ahead of
30 other control messages in the queue for processing. If multiple levels of priority

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are present, the placement of the control message will be based on the priority in AVP **606** as compared to the priority of other messages in the queue.

A number of different types of AVPs, other than a priority AVP, may be located within payload **604**. In the depicted examples, these AVPs and the servers
5 processing the AVPs follow the Diameter protocol. More information on the Diameter protocol may be found in draft-calhoun-diameter-framework-07.txt and draft-calhoun-diameter-14.txt from the IETF.

With reference next to **Figure 7**, a diagram of an IP packet is depicted in accordance with a preferred embodiment of the present invention. In this
10 example, IP packet **700** is an example of an IP packet sent onto an IP network, such as IP network **114** in **Figure 1**. In this example, IP packet **700** includes a header **702** and a payload **704**. Payload **704**, in this example, contains an entire control message, such as control message **600** in **Figure 6**. Depending on the size of the control message, the control message may be placed into multiple IP
15 packets for transmission on the IP network.

To provide for priority handling of the control message contained within IP packet **700** by nodes in which an application processing control messages is absent, an indicator is set within header **702** of IP packet **700**. In the depicted examples, a differential services (DS) field **706** is set to provide priority or
20 precedence for the handling of IP packet **700** by nodes, which do not examine the control message in the processing of IP packet **700**. In accordance with a preferred embodiment of the present invention, this field is set by a network layer, such as network layer **508** in **Figure 5**, in response to a call from an application in an application layer within the protocol stack. In particular, DS field **706** is set to
25 provide for priority or precedence handling of control messages placed into IP packets routed by nodes, such as routers, which do not examine the control message itself when routing the IP packets. When DS field **706** is set, a node receiving IP packet **700** will provide priority handling for the packet. In the depicted examples, packets, such as IP packet **700**, are typically placed into a
30 queue for processing or routing to another node. The packets are processed using

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a FIFO process. IP packet **700** is placed in the queue ahead of other packets in which a DS field is not set.

Turning now to **Figure 8**, an example of a priority AVP format is depicted in accordance with a preferred embodiment of the present invention. AVP **800** is an example of an AVP format used for a priority AVP. In this example, AVP **800** includes AVP code field **802**, which identifies the particular attribute. AVP code field **802** contains the appropriate code to identify AVP **800** as a priority AVP.

AVP length field **804** in this example is two octets and indicates the length of AVP **800**. In other words, AVP length **804** is used to identify when AVP **800** ends and another AVP begins. Reserved field **806** is reserved for other uses. Flags field **808** contains flags as described in the diameter based protocol. In this example, H and E may be set depending on the security model used, while M, V, T, and P are not set. Integer 32 field **810** contains the priority number of the issuing device. In particular, a number of different codes may be used in integer 32 field **810** to provide priority or precedence handling of the control message itself. For example, platinum, gold, silver, and bronze levels may be implemented. In such a case, platinum receives the highest priority while bronze receives the lowest priority. In the depicted examples, a single AVP code is used for all priorities, with the level of the priority being placed within the data section of the AVP.

Turning now to **Figure 9**, a flowchart of a process for generating a control message is depicted in accordance with a preferred embodiment of the present invention. The process illustrated in **Figure 9** may be implemented in an application layer, such as application layer **502** in **Figure 5**, for use in a server, such as visited AAA server **124** or home AAA server **129** in **Figure 1**.

The process begins by identifying time sensitive data in the message (step **900**). In this case, the control message itself is the time sensitive data. In response to identifying time sensitive data, a priority AVP is generated (step **902**). This priority AVP may be an AVP, such as AVP **800** in **Figure 8**. Next, the priority AVP is placed in the control message (step **904**). This priority AVP is the

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priority indicator for the control message in this example. This priority AVP is a priority AVP, such as AVP **606** in **Figure 6**.

Additionally, a call is sent to an IP layer in the protocol to set the priority indicator (step **906**). In the depicted example, this call is made to a network layer, such as network layer **508** in **Figure 5**. The priority indicator set in response to this call is a priority indicator in a header of the packet used to transport the control message. In the depicted examples, this priority indicator is a DS field, such as DS field **706** in **Figure 7**. This call is used to provide priority handling of packets used to transport control messages. The setting of this indicator allows for priority handling of the packet in nodes, which do not examine control messages. In this manner, best efforts handling in the transport of the control message from a source to a destination is ensured even when the message is being transported through nodes, which do not look at the contents of the packets themselves. The control message is then sent for transport (step **908**) with the process terminating thereafter. This step involves sending the control message to the next layer in the protocol stack, such as a transport layer.

Of course, the application also may make additional calls or send additional messages to ensure that the control message reaches the target with minimal delay. For example, steps **910** and **912** are optional steps, which may be implemented in a system using resource reservation protocol (RSVP). If RSVP is used, the process in **Figure 9** also generates a reservation message (step **910**) and sends the reservation message (step **912**).

RSVP is a network-controlled protocol that enables Internet applications to obtain special qualities of service for data flow. Data flow occurs between two points, such as a source or sending host and a target or receiving host. RSVP works in conjunction with routing protocols and installs the equivalent of dynamic access list along the routes that routing protocols calculate or establish. RSVP data flows are generally characterized by sessions over which data-packets flow. A session is a set of data flows with the same uni-task or multi-task destination in these examples. A path message is a RSVP message sent by a sender or source forwarded along a uni-task or multi-task route provided by routing protocols

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located in various nodes. The path message is used to store the path state in each node. The path data is used to route reservation messages in the reverse direction. With RSVP, bandwidth may be reserved in nodes, such as routers, for selected data flows to ensure that the data flow occurs without delay. RSVP typically is implemented in a transport layer, such as transport layer 506 in Figure 5. More information on RSVP may be found in RFC 2205, which is available from the IETF.

The setting of an indicator in the header of an IP packet and the use of a mechanism to reserve bandwidth for processing selected packets are intended as examples of mechanisms used to provide best efforts processing of control messages. These examples are not intended as limitations as to the types of mechanisms that may be used to ensure that control messages are processed as quickly as possible at nodes, including nodes routing packets containing control messages in which the control messages themselves are not examined.

Turning now to Figure 10, flowchart of a process used to process control messages is depicted in accordance with a preferred embodiment of the present invention. The process in Figure 10 may be implemented in an application layer, such as application layer 502 in Figure 5. These processes may be used in a server, such as visited AAA server 124 or home AAA server 129 in Figure 1.

The process begins by receiving a control message (step 1000). This control message is received after IP packets have received by a lower layer in the protocol and placed into a form for use by the application. The control message is parsed (step 1002). A determination is made as whether a priority AVP is present within the control message (step 1004). If a priority AVP is present, then the control message is processed based on a priority indicated in the AVP (step 1006) with the process termination thereafter. If a priority AVP is absent in the control message, then the control message is processed normally (step 1008) with the process terminating thereafter.

Priority in processing may be achieved by placing the control message or the data from the control message higher up in a queue or buffer for processing

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with respect to other control messages in which priority is absent or in which priority is lower than that of the current control message.

5 A similar process is followed by router processing IP packets. Upon receiving an IP packet, the router examines the header to see whether an indicator is present or set for priority handling of the IP packet.

10 Thus, the present invention provides a priority based mechanism used to control messaging within a packet-based network, such as an IP network. In these examples, control messages are an example of messages containing time sensitive information that is sensitive to delays in delivery. The mechanism of the present invention allows for these types of control messages to be appropriately handled when received by different nodes, such as a router, a device/platform hosting FA functionality, an AAA broker, or an AAA server. The priority handling is provided through the setting of various indicators within the messages and packets by the application layer. In this manner, the processing of messages and IP
15 networks may be handled more quickly to avoid delays in delivering data to delay sensitive applications.

20 It is important to note that while the present invention has been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in the form of a computer readable medium of instructions and a variety of forms and that the present invention applies equally regardless of the particular type of signal bearing media actually used to carry out the distribution. Examples of computer readable media include recordable-type media such a floppy disc, a hard disk drive, a RAM, CD-ROMs, and transmission-type media,
25 such as digital and analog communications links.

The description of the present invention has been presented for purposes of illustration and description and is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. For example, although the depicted
30 examples use control messages, the processes of the present invention may be implemented for other types of data and messages other than control messages.

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- Further, the processes may be applied using other protocols other than those illustrated herein. The embodiment was chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various
- 5 embodiments with various modifications as are suited to the particular use contemplated.

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